

LIFE HISTORY AND DESCRIPTIONS OF ADULTS AND IMMATURE STAGES OF *ACIURINA IDAHOENSIS* STEYSKAL (DIPTERA: TEPHTRITIDAE) ON *CHRYSOTHAMNUS VISCIDIFLORUS* (HOOKER) NUTTALL IN SOUTHERN CALIFORNIA

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Abstract.—*Aciurina idahoensis* Steyskal is a univoltine, monophagous fruit fly that forms distinctive, leafy, axillary bud galls on *Chrysothamnus viscidiflorus* (Hooker) Nuttall, its only known host plant, throughout the western United States. Documentation is provided for the first time for the genus *Aciurina*, and more importantly, for the family Tephritidae as a whole, that the wing patterns of the adults of this species are strongly sexually dimorphic in southern California, but not dimorphic, or much less strongly or consistently so, in other parts of its range, e.g., in Idaho. The egg, first through third instars, and puparium of *A. idahoensis* are described, illustrated, and compared with other southern California *Aciurina* spp. The egg has a long pedicel with a knoblike, anterior apex. The third instar is characterized by having only one row of verruciform sensilla circumscribing the prothorax and no abdominal lateral spiracular sensilla. *Aciurina idahoensis* co-occurs with *A. semilucida* (Bates) on *C. viscidiflorus* at lower altitudes (<1800 m) in southern California; whereas, this host plant is partitioned altitudinally and shared by *A. ferruginea* (Doane) and *A. michaeli* Goeden at higher altitudes (>2100 m).

Key Words: Insecta, *Aciurina*, *Chrysothamnus*, biology, galls, regional sexual dimorphism, adult taxonomy, immature taxonomy, parasitoids

Six *Aciurina* spp. (Diptera: Tephritidae) forming galls on *Chrysothamnus* or *Baccharis* spp. (Asteraceae) in southern California have been studied by us in recent years. This paper follows those on *A. thoracica* Curran (Headrick and Goeden 1993), *A. ferruginea* (Doane), and *A. michaeli* Goeden (Goeden and Teerink 1996) in a series projected to treat at least two more southern California species of *Aciurina*. Herein, we describe our findings to date on the tephritid that Wangberg (1981) called "*Aciurina* sp. A" and Steyskal (1984) named *A. idahoensis* Steyskal.

MATERIALS AND METHODS

Our field studies were conducted on *Chrysothamnus viscidiflorus* (Hooker) Nut-

tall (Asteraceae) in Deep Spring Valley, the southernmost extension of the Great Basin biome (Munz 1974, Hall 1991), located northeast of the Westgard Pass in the White-Inyo Mountain Range, Inyo Co., California. Galls containing larvae and puparia of *A. idahoensis* were sampled from plants in Payson Canyon at 1770 m at the southwest end of the Valley during March–June, 1992–94. Excised galls were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Ten ova dissected from mature females and 16 larvae and 4 puparia dissected from galls were preserved in 70% EtOH for scanning

electron microscopy (SEM). All other fully grown larvae and puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM later were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH, critically point dried, mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cagings were used for longevity studies and oviposition tests in the insectary of the Department of Entomology, University of California, Riverside, at $25 \pm 1^\circ\text{C}$, and 14/10 (L/D) photoperiod. Virgin male and female flies obtained from emergence vials as well as field-swept adults were paired in clear-plastic petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 1991) for direct observations, videorecording, and still-photography of their courtship and copulation behavior to be reported elsewhere (Headrick and Goeden, unpublished data).

Plant names used in this paper follow Munz (1974); tephritid names and nomenclature follow Foote et al. (1993). Morphological terminology and telegraphic format used to describe the immature stages follows Headrick and Goeden (1993), Goeden et al. (1993, 1994a, b, 1995a, b), Goeden and Teerink (1996), and our earlier works cited therein. Means $\pm$ SE are used throughout this paper. Voucher specimens of reared adults of *A. idahoensis* and its parasitoids reside in the research collections of RDG; preserved specimens of eggs, larvae,

and puparia are stored in the research collection of JAT.

RESULTS AND DISCUSSION

Taxonomy

Adult.—*Aciurina idahoensis* was described by Steyskal (1984) from specimens of what he suggested were "likely" both *Aciurina* sp. A and sp. B of Wangberg (1981). However, Goeden and Teerink (1996) demonstrated conclusively that *Aciurina* sp. B was *A. ferruginea*, and described the maker of the gall formerly attributed to *A. ferruginea* (Tauber and Tauber 1967, Wangberg 1981) as *A. michaeli* Goeden. Thus, only the *Aciurina* sp. A of Wangberg (1981) is *A. idahoensis* (Steyskal 1984, Foote et al. 1993, Goeden and Teerink 1996).

Steyskal (1984) in describing *A. idahoensis* from specimens from Idaho, from where it then solely was known (Foote et al. 1993), was unaware that the adults of this species show strong sexual dimorphism in their wing patterns elsewhere, e.g., in southern California, from where we now also report this species. Photographs are provided of the right wings of specimens of a male (Fig. 1A) and female (Fig. 1B) from Idaho comparable to those of paratypes obtained from the U.S. National Museum of Natural History, Washington, DC, and to the majority [70 (75%)] of 93 ♂ and [57 (78%)] of 73 ♀ from Idaho examined from the W. F. Barr Entomological Museum Collection, University of Idaho. Figure 1A also is comparable to the single photograph of a right wing of *A. idahoensis* (sex unstated) in Foote et al. (1993); whereas, Fig. 1B is comparable to "a variation found in ♂ specimens", and the only wing photograph provided of *A. idahoensis* by Steyskal (1984). Compare the preceding wing patterns with those of male (Fig. 1C) and female (Fig. 1D) *A. idahoensis* individually reared from galls like those described and illustrated by Wangberg (1981) for *Aciurina* sp. A and swept from *C. viscidiflorus* at our study site in Deep Spring Valley, Califor-

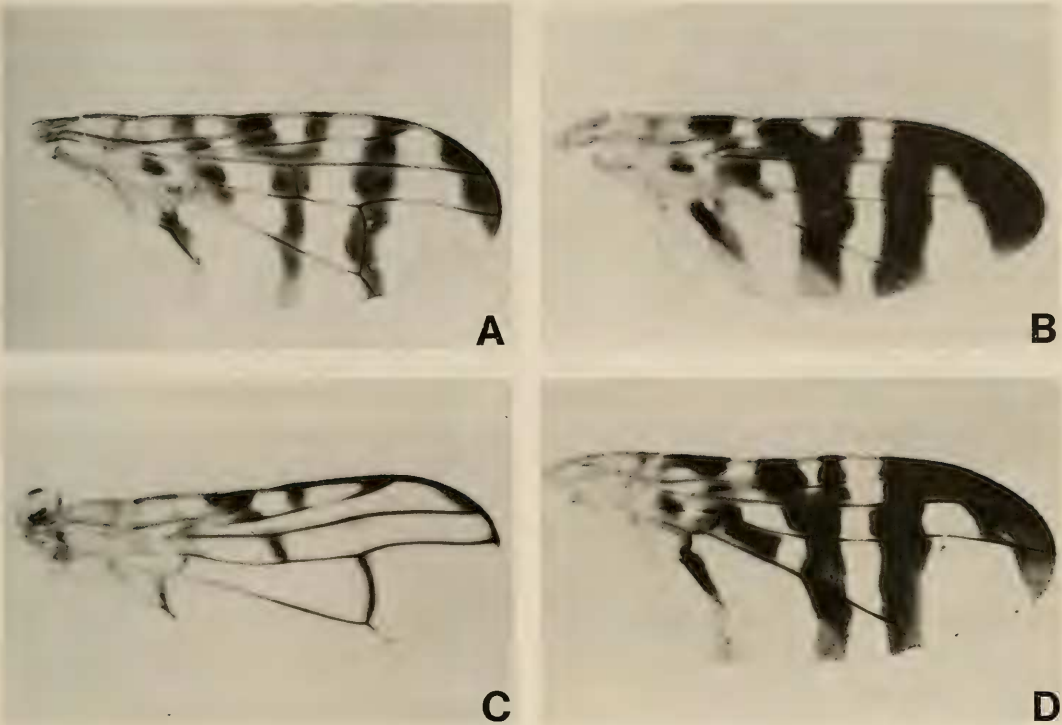


Fig. 1. Right wings of *Acirina idahoensis*: (A) male from Idaho, (B) female from Idaho, (C) male from California, (D) female from California.

nia. These photographs document for the first time the pronounced regional variation in the wing patterns of *A. idahoensis* within its range in North America. This variation is of such magnitude that the strong sexual dimorphism in wing patterns that occurs in California is absent, or much less strongly or consistently expressed, between the sexes in Idaho (see below). Goeden and Teerink (1996) first reported the incidence of sexual dimorphism among *Acirina* spp. in the wing patterns of both *A. ferruginea* and *A. michaeli*, but this variation between the sexes of these two species pales in comparison to that shown by *A. idahoensis* in California (Fig. 1C and D). Sexual dimorphism also is known to occur in *A. semilucida* (Bates) in California (Goeden and Teerink, unpublished data), and will be described separately in our next paper. The discovery of regional sexually dimorphic wing patterns helps to explain the highly

variable nature of the dark markings in the wing patterns of flies lumped together as *A. bigeloviae* by Steyskal (1984) and Foote et al. (1993).

In the wings of all 12 males of *A. idahoensis* examined from California, the median dark area in cell c (Fig. 1A) is absent (Fig. 1C). Also, the dark crossband otherwise passing through vein r-m in Idaho specimens (Fig. 1A) is reduced in California males to a dark spot wholly or partly covering this vein (Fig. 1C), and its anterior bifurcation is reduced to a dark spot in the pterostigma (Fig. 1C), and a dark spot on the costa apicad of R_1 (Fig. 1C). The complete crossband running through vein dm-cu without an accessory arm in Idaho specimens (Fig. 1A) is reduced in California males to a slight darkening of the apex of cell r_1 , or at least to a darkening of the apices of vein R_{2+3} and costa at this juncture (Fig. 1C), as well as the apex of vein

dm-cu (Fig. 1C). Furthermore, the apicocostal band present in Idaho specimens (Fig. 1A) is reduced in California males to a slight darkening of apices of cells r_{2+3} and r_{4+5} at the apices of veins R_{4+5} and M, respectively, along the costa (Fig. 1C). Because the pterostigma of these 12 males from California was no more than 1.5 times as long as its greatest width (Fig. 1C), rather than at least twice as long as its greatest width as in *A. bigeloviae*, these males key to *A. notata* (Coquillett) in the keys of Steyskal (1984) and Foote et al. (1993). Were it not that the rare species, *A. notata* (Foote et al. 1993), was described from a female (Coquillett 1899) with a wing pattern totally dissimilar from those illustrated in Fig. 1B and 1D, remains known only from New Mexico (Foote et al. 1993), and was reported from a different type of gall on a different host [*C. nauseosus* (Pallen) Britton, Cockerell 1900], we might have suggested that California *A. idahoensis* males were in fact *A. notata*. Instead, we now merely note that male *A. idahoensis* from California also run to *A. notata* in the key to the North American *Aciurina* in Foote et al. (1993), though based on the following findings remain readily separable by their different galls and host plants.

After examination of the types of *A. notata* from Albuquerque, New Mexico, galls of this species collected by Cockerell (1900) from Santa Fe, New Mexico, and seven other specimens of adults reared from the latter galls, Bates (1935) concluded that both adults and galls, though similar, were distinct from those of *A. semilucida* (Bates), a rare species in southern California to be discussed in our next paper in this series (Goeden and Teerink, unpublished data). And, Bates (1935) noted that some of these specimens of *A. notata* had a wing pattern "... reduced to a few small brown spots as described (but not illustrated) by Coquillett. ... (our parentheses)" (1899). We, too, after examination confirm that two of the galls of *A. notata* collected by Cockerell (1900) from *A. nauseosus*, apparently

among those examined by Bates (1935), are very different from those of *A. idahoensis* described herein, from the gall mounted with a paratype of *A. semilucida*, and from series of galls of *A. semilucida* examined by us from Idaho and southern California (Goeden and Teerink, unpublished data). Furthermore, a male specimen of *A. notata* from Cockerell's (1900) series from Santa Fe, also presumably among those examined by Bates (1935) appears much like the lightest wing pattern illustrated for *A. notata* by Steyskal (1984), the wing pattern for *A. notata* figured in Foote et al. (1993), as well as the male of *A. idahoensis* from California (Fig. 1C).

Variations also were found within and between sexes in specimens of *A. idahoensis* from Idaho and California that temper characters used in the keys of Steyskal (1984) and Foote et al. (1993). Steyskal (1984) stated that the apicocostal band usually is separated from the transverse band through vein dm-cu in males from Idaho. Fifteen (16%) of the 93 ♂ examined from Idaho, like most females (Fig. 1B), had wings with these bands joined; whereas, in 14 (19%) of the 73 ♀, like most males (Fig. 1A), these bands were distinctly separated. One female each from California and Idaho (a non-paratype) had the apicocostal band connected along vein CuA_1 , as noted for one paratype by Steyskal (1984). Additional variations noted by us among specimens from Idaho were five males in which the crossband through vein r-m was broken in cell dm, two other males in which the apicocostal band was broken in cell r_{4+5} , leaving a dark spot at the end of vein M, and one male with a faint, round spot at the apicocentral margin of cell m.

Immature stages.—*Egg*.—Ova (Fig. 2A) white, opaque, smooth; with an elongate-ellipsoidal body, 0.51 ± 0.007 (range, 0.44–0.56) mm long, 0.19 ± 0.002 (range, 0.16–0.20) mm wide ($n = 25$), smoothly rounded at tapered posterior end; and with an elongate, anterior pedicel, 0.37 ± 0.006 (range, 0.26–0.40) mm long, 0.01 mm wide



Fig. 2. Egg of *Aciurina idahoensis*: (A) habitus, (B) apex of pedicel.

medially, and 0.04 mm wide at knoblike, anterior apex (Fig. 2B).

The eggs of *A. idahoensis* are stalked like those of *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996), all three of which differ greatly in appearance from the short-pedicelled, partly reticulated egg of *A. thoracica* (Headrick and Goeden 1993). The respiratory function of the elongate pedicel of these eggs was first suggested for *A. michaeli* by Tauber and Tauber (1967) and was supported with morphological and biological data by Goeden and Teerink (1996). The egg bodies and pedicels of *A. idahoensis* are shorter on average than these parts of the eggs of both *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996).

Third instar.—Superficially smooth, ovoidal, anteriorly and posteriorly rounded,

minute acanthae ventrally (Fig. 3A); gnathocephalon conical, rugose pads laterad of mouth lumen; pair of elongated dorsal petals near mouth lumen (Fig. 3B-1); paired dorsal sensory organs dorsomedial of anterior sensory lobes, each consisting of a dome-shaped papilla (Fig. 3B-2, C-1); anterior sensory lobes bear the terminal sensory organ (Fig. 3C-2), pit sensory organ (Fig. 3C-3), lateral sensory organ (Fig. 3C-4), and supralateral sensory organ (Fig. 3C-5); stomal sense organs ventrolaterad of anterior sensory lobes, near mouth lumen (Fig. 3B-3, D-1); lateral sensillum located laterad of anterior sensory lobe (Fig. 3B-4), ventrolateral sensillum located ventrolaterad of stomal sense organs, each consisting of a verruciform sensillum; mouth hooks tridentate, medial tooth reduced, teeth conical, rounded apically (Fig. 3D-2); median oral lobe tapered anteriorly, flattened ventrally, attached to labial lobe (Fig. 3D-3); prothorax smooth, minute acanthae ventrally, verruciform sensilla circumscribe prothorax; anterior thoracic spiracles dorsolateral on posterior margin of prothorax, consisting of 3–5 oval papillae (Fig. 3E); meta-thoracic lateral spiracular complex consists of an open spiracle (Fig. 3F-1), and single verruciform sensillum (Fig. 3F-2); abdominal lateral spiracular complex consists of open spiracle; caudal segment bears posterior spiracular plates (Fig. 3G-1, H); posterior spiracular plates with three oval rimae, ca. 0.032 mm in length (Fig. 3H-1), and four interspiracular processes with 2–4 branches each, longest measuring 0.013 mm (Fig. 3H-2); two compound sensilla ventrad of posterior spiracular plates consist of a stelex sensillum (Fig. 3G-2), and a verruciform sensillum (Fig. 3G-3); stelex sensilla surround margin of caudal segment in a 2-dorsal, 4-ventral arrangement (Fig. 3G-4).

Aciurina idahoensis closely resembles *A. ferruginea* and *A. thoracica* in general habitus (Goeden and Teerink 1996, Headrick and Goeden 1993). These three species differ from *A. michaeli* which is expanded

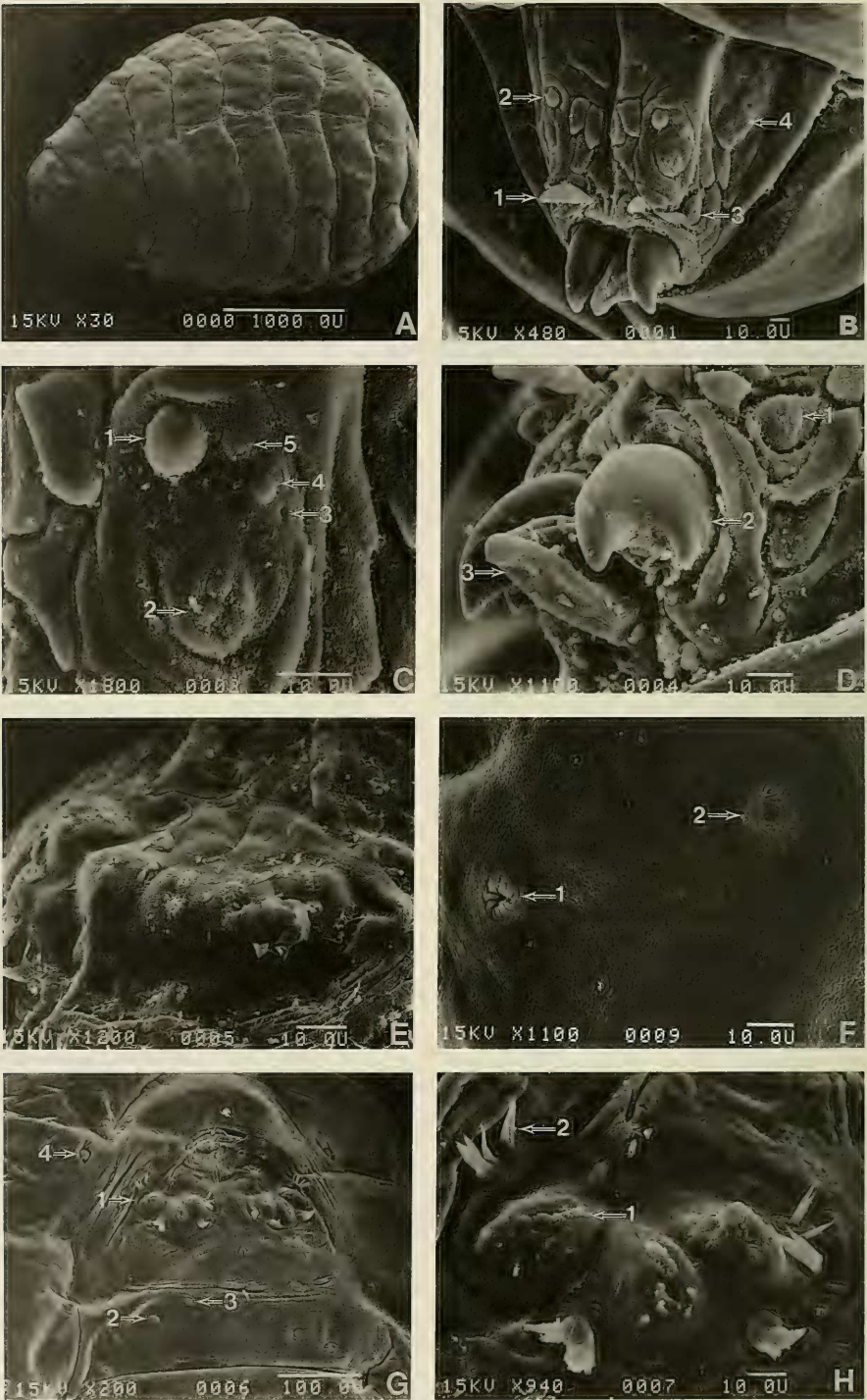


Fig. 3. Third instar of *Aciurina idahoensis*: (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—elongated dorsal petal, 2—dorsal sensory organ, 3—stomal sense organ, 4—lateral sensillum; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ; (D) gnathocephalon, ventrolateral view, 1—stomal sense organ, 2—mouth hooks, 3—median oral lobe; (E) anterior thoracic spiracle; (F) metathoracic lateral spiracular complex, 1—

dorsally in abdominal segments III–V forming a distinct hump (Goeden and Teerink 1996). *Aciurina idahoensis* differs from *A. thoracica* in having only one row of verruciform sensilla circumscribing the prothorax, no abdominal lateral spiracular sensilla, and larger branched interspiracular processes (Headrick and Goeden 1993). *Aciurina ferruginea* differs from *A. idahoensis* in having serrated rugose pads laterad of the mouth lumen, three metathoracic lateral spiracular sensilla, and many-branched interspiracular processes (Goeden and Teerink 1996).

Second instar.—Superficially smooth, ovoidal, anteriorly and posteriorly rounded, with minute acanthae ventrally and laterally along abdominal segment lines (Fig. 4A); gnathocephalon conical, rugose pads laterad of mouth lumen; paired dorsal sensory organs dorsomedial of anterior sensory lobes (Fig. 4B-1, C-1); anterior sensory lobes (Fig. 4B-2, C) bear the terminal sensory organ (Fig. 4C-2), pit sensory organ (Fig. 4C-3), lateral sensory organ (Fig. 4C-4), and supralateral sensory organ; stomal sense organs ventrolaterad of anterior sensory lobes (Fig. 4B-3, D-1); lateral sensillum laterad of anterior sensory lobes (Fig. 4B-4, D-2), ventrolateral sensillum ventrolaterad of stomal sense organs (Fig. 4D-3), each consisting of a verruciform sensillum; mouth hooks bidentate, lateral tooth small (Fig. 4D-4); median oral lobe rounded anteriorly, attached to labial lobe (Fig. 4D-5); labial lobe bears two pore sensilla (Fig. 4D-6); prothorax smooth, minute acanthae ventrally, verruciform sensilla circumscribe segment; anterior thoracic spiracles dorso-lateral on posterior margin of prothorax, each consisting of 3–5 oval papillae (Fig. 4E); thoracic lateral spiracular complexes not observed; abdominal lateral spiracular

complex consist of an open spiracle (Fig. 4F); caudal segment bears posterior spiracular plates (Fig. 4G-1); posterior spiracular plates bear three oval rimae and four interspiracular processes (structures obscured in Fig. 4G); compound sensilla ventrad of posterior spiracular plates (Fig. 4G-2), consist of a stelex sensillum (Fig. 4H-1) and a raised, verruciform sensillum (Fig. 4H-2) in one pair of sensilla, and two raised verruciform sensilla in the other; stelex sensilla surround caudal segment in 2-dorsal, 4-ventral arrangement (Fig. 4G-3).

The second instar closely resembles the third instar in general habitus. Most morphological features of the second instar are similar in shape and placement to those of the third instar with a few exceptions. Minute acanthae along segmental lines are more noticeable in the second instar. The gnathocephalon differs slightly from the third instar. The pair of elongated dorsal petals present in the third instar are not found in the second instar. The mouth hooks are bidentate in the second instar. On the caudal segment, the compound sensilla ventrad of the posterior spiracular plates contain only one raised verruciform sensillum in one of the pairs, whereas those in the third instar consist of a stelex sensillum and a verruciform sensillum in both pairs.

First instar.—Superficially smooth, oblong-spheroidal, anteriorly and posteriorly rounded, minute acanthae circumscribing segmental lines (Fig. 5A); gnathocephalon conical, smooth, lacking rugose pads (Fig. 5B); pair of dorsal petals near mouth lumen (Fig. 5B-1); paired dorsal sensory organs dorsomedial of anterior sensory lobes (Fig. 5B-2, C-1); anterior sensory lobes bear terminal sensory organ (Fig. 5C-2), lateral sensory organ (Fig. 5C-3) (pit sensory organ not observed), and supralateral sensory

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spiracle, 2—verruciform sensillum; (G) caudal segment, 1—posterior spiracular plates, 2—compound sensillum, stelex sensillum, 3—compound sensillum, verruciform sensillum, 4—stelex sensillum; (H) posterior spiracular plate, 1—rima, 2—interspiracular process.

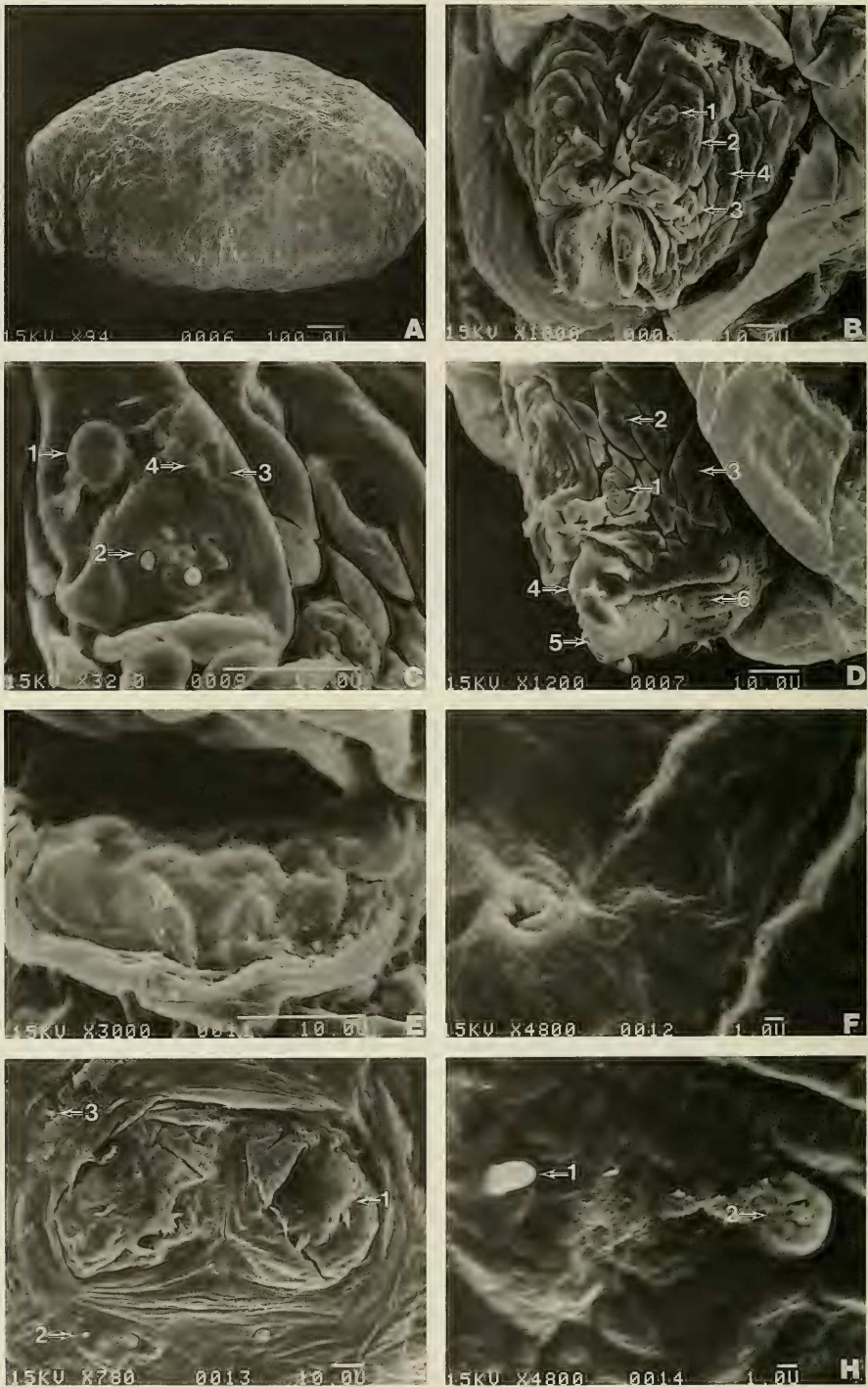


Fig. 4. Second instar of *Aciurina idahoensis*: (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—anterior sensory lobe, 3—stomal sense organ, 4—lateral sensillum; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ; (D) gnathocephalon, ventrolateral view, 1—stomal sense organ, 2—lateral sensillum, 3—ventrolateral sensillum, 4—mouth hooks, 5—median oral lobe, 6—labial lobe sensilla; (E) anterior thoracic spiracle; (F)

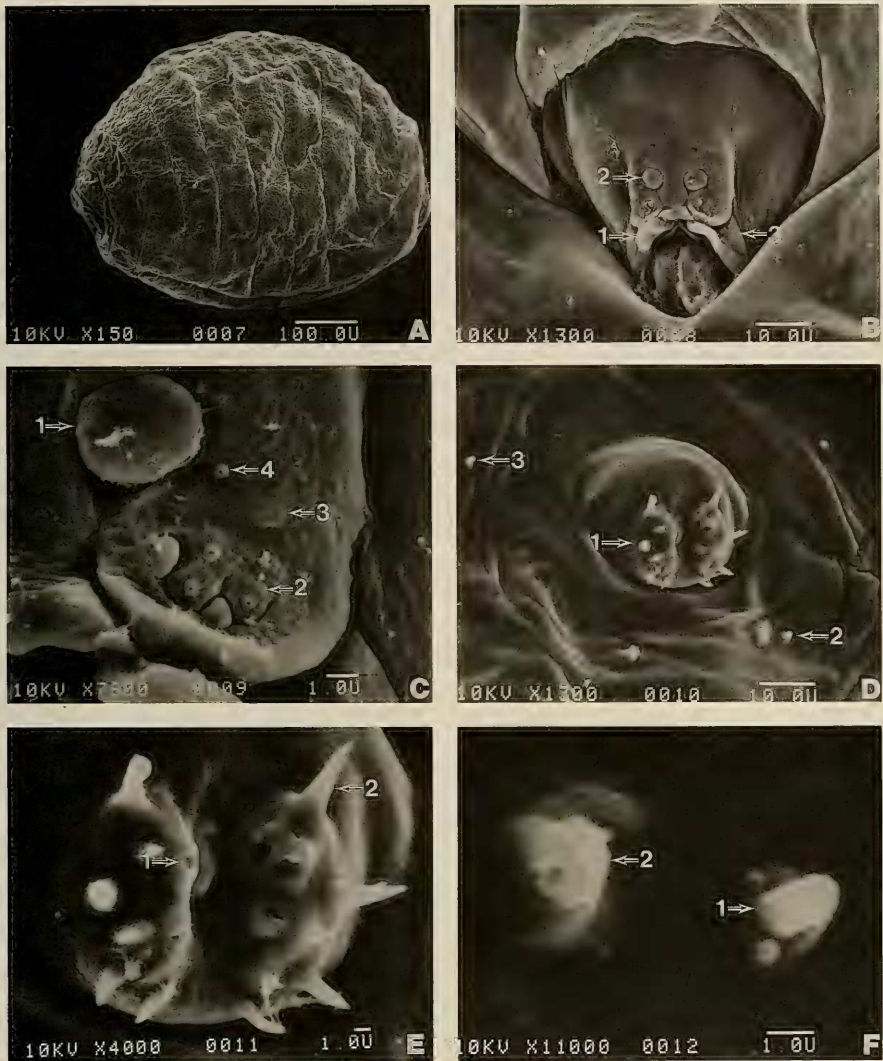


Fig. 5. First instar of *Aciurina idahoensis*: (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—dorsal petal, 2—dorsal sensory organ, 3—stomal sense organ; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—lateral sensory organ, 4—supralateral sensory organ; (D) caudal segment, 1—posterior spiracular plate, 2—compound sensilla, 3—stelex sensillum; (E) posterior spiracular plate, 1—rima, 2—interspiracular process; (F) compound sensillum, 1—stelex sensillum, 2—tuberculate, medusoid chemosensillum.

organ (Fig. 5C-4); stomal sense organs ventrolaterad of anterior sensory lobes indistinct (Fig. 5B-3); lateral and ventral sensilla indistinct; mouth hooks were not visible;

median oral lobe obscured; prothorax smooth, lacks minute acanthae ventrally; anterior thoracic spiracles absent; lateral spiracular complex not observed; caudal

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abdominal lateral spiracle; (G) caudal segment, 1—posterior spiracular plates, 2—compound sensillum, 3—stelex sensillum; (H) compound sensillum, 1—stelex sensillum, 2—verruciform sensillum.

segment bears posterior spiracular plates (Fig. 5D-1); posterior spiracular plates bear two round rimae, ca. 0.002 mm in length (Fig. 5E-1), and four interspiracular processes, longest measuring 0.005 mm in length (Fig. 5E-2); compound sensilla ventrad of posterior spiracular plates consist of a stelex sensillum (Fig. 5F-1), and a tuberculate medusoid chemosensillum (Fig. 5F-2) in one sensillum and a tuberculate medusoid chemosensillum in the other (Fig. 5D-2); stelex sensilla surround margin of caudal segment in a 2-dorsal, 4-ventral arrangement (Fig. 5D-3).

First instars differ from the second and third instars in general habitus, being more spheroidal in shape. The minute acanthae are limited to the segmental lines, but circumscribe the segments. The gnathocephalon is quite different from the other two instars. The first instar is smooth, lacking rugose pads, the anterior sensory lobes and stomal sense organs are not as well-defined, and the lateral and ventrolateral sensilla are not present. Unfortunately, the mouth hooks and median oral lobe were not visible in the single prepared specimen. The first instar lacks anterior thoracic spiracles and the lateral spiracular complex was not observed. The compound sensilla ventrad of the posterior spiracular plates are more distinct than in the other two instars. The first instar larva of *A. idahoensis* closely resembles that of *A. ferruginea* (Goeden and Teerink 1996).

Puparium.—Smooth, elongate-reniform, reddish-brown (Fig. 6A); anterior end bears anterior thoracic spiracles (Fig. 6B-1), invagination scar (Fig. 6B-2), and verruciform sensilla (Fig. 6B-3); caudal end bears posterior spiracular plates (Fig. 6C); posterior spiracular plates bear three oval rimae, ca. 0.052 mm in length (Fig. 6C-1), and four interspiracular processes (Fig. 6C-2). Nineteen averaged 3.84 ± 0.17 (range, 3.18–6.72) mm in length and 1.92 ± 0.04 (range, 1.67–2.32) mm in width.



Fig. 6. Puparium of *Aciturina idahoensis*: (A) habitus, anterior to left; (B) anterior end, 1—anterior thoracic spiracle, 2—invagination scar, 3—verruciform sensillum; (C) caudal end, posterior spiracular plate, 1—rima, 2—interspiracular process.

DISTRIBUTION AND HOSTS

Heretofore, *A. idahoensis* was known only from Idaho (Steyskal 1984, Foote et al. 1993); however, its distribution probably

parallels that of its sole host plant, *C. viscidiflorus*, first reported by Wangberg (1981) for "*Aciurina* sp. A" to include both "ssp. *viscidiflorus* (Eaton) and ssp. *stenophyllus* (Gray)". Wangberg (1981) remarked that "... this species was common throughout southern Idaho and often abundant at various sites, ..." and that its distribution "... appears continuous and co-extensive with its host plant." *Aciurina idahoensis* has only been found in Deep Spring Valley in California.

BIOLOGY

Egg.—Eggs are deposited singly in axillary or (rarely) terminal buds of the current year's branch growth, judging from the occurrence of only one larva per gall and the sessile nature of the gall, indicative of little bud growth at the time of oviposition. The stalked eggs of *A. idahoensis*, like those of *A. ferruginea* and *A. michaeli*, suggest an adaptation for respiration in resin-covered buds of their common host plant (Goeden and Teerink 1996). Young galls bearing second instars (Fig. 7A) collected in late March in southern California bore many dead basal leaves indicative of earlier gall growth and first-instar larval development during the previous year, probably progressing very slowly since oviposition in late-spring (May–June), and egg eclosion sometime during the subsequent summer or fall, then overwintering (July–February) until rapid concurrent host-plant, gall, and insect growth accelerate in the following spring (March–May). Thus, in our opinion, the overwintering stage is the first instar. Wangberg (1981), instead, inferred the egg stage to last ca. 320 days in Idaho "... based on the time of adult emergence and the first signs of gall growth." Detection of the earliest stages of *Aciurina* spp. gall development and ascertaining the overwintering stage(s) are difficult (Goeden and Teerink 1996), and are further complicated by the presence of at least four species of *Aciurina* and one species of *Procecidochares* (Diptera: Tephritidae) as well as Lepidop-

tera and Cecidomyiidae, all forming bud galls on *C. viscidiflorus* (Wangberg 1980, 1981; Goeden and Teerink 1996, unpublished data).

Larva.—The gall of *A. idahoensis* is a stunted axillary branch, or rarely a branch apex, reminescent of a pine cone (Steyskal 1984). As such, it is subspheroidal when young (Fig. 7A), elongating into an ovoid as it grows and matures (Fig. 7D, E). The gall also bears basally expanded, sessile, linearly tapered, and apically pointed, smooth-margined leaves, which are shortened and more densely packed apically (Fig. 7E). The oldest, basal, overwintered leaves were dead and tan (Fig. 7A, B); the new leaf growth light green (Fig. 7B). The gall body is largely composed of whitish, expanded leaf bases, nodes, and expanded pith parenchyma (Fig. 7D, F). The gall is uniloculate (monothalmus) and characteristically contains a small, initially subspheroidal (Fig. 7C), later narrow, elongate-ellipsoidal, central open chamber within which the larva feeds (Fig. 7D). This gall is quite unlike the axillary bud galls of *A. ferruginea* and *A. michaeli*, both externally and internally (Goeden and Teerink 1996), and indeed, more closely resembles the galls of an apparently unnamed *Procecidochares*, misidentified as *P. stonei* Blanc and Foote (Tauber and Tauber 1968, Green et al. 1993), and certain Cecidomyiidae, all of which form fleshy, leafy, bud galls with narrow, elongate, cylindrical central cavities on *C. viscidiflorus* in southern California (Goeden and Teerink, unpublished data).

Eleven galls containing second instars averaged 12.0 ± 0.7 (range, 6.8–16.0) mm in length and 6.7 ± 0.3 (range, 6.0–9.0) in width (Fig. 7B, C). The gall cavities measured 5.0 ± 0.5 (range, 1.3–7.2) mm in length by 1.6 ± 0.1 (range, 0.8–2.3) mm in width (Fig. 7C). The inner surface of the chamber was shallowly pitted by larval feeding. The gall walls averaged 0.66 ± 0.06 (range, 0.28–0.93) mm in greatest thickness.

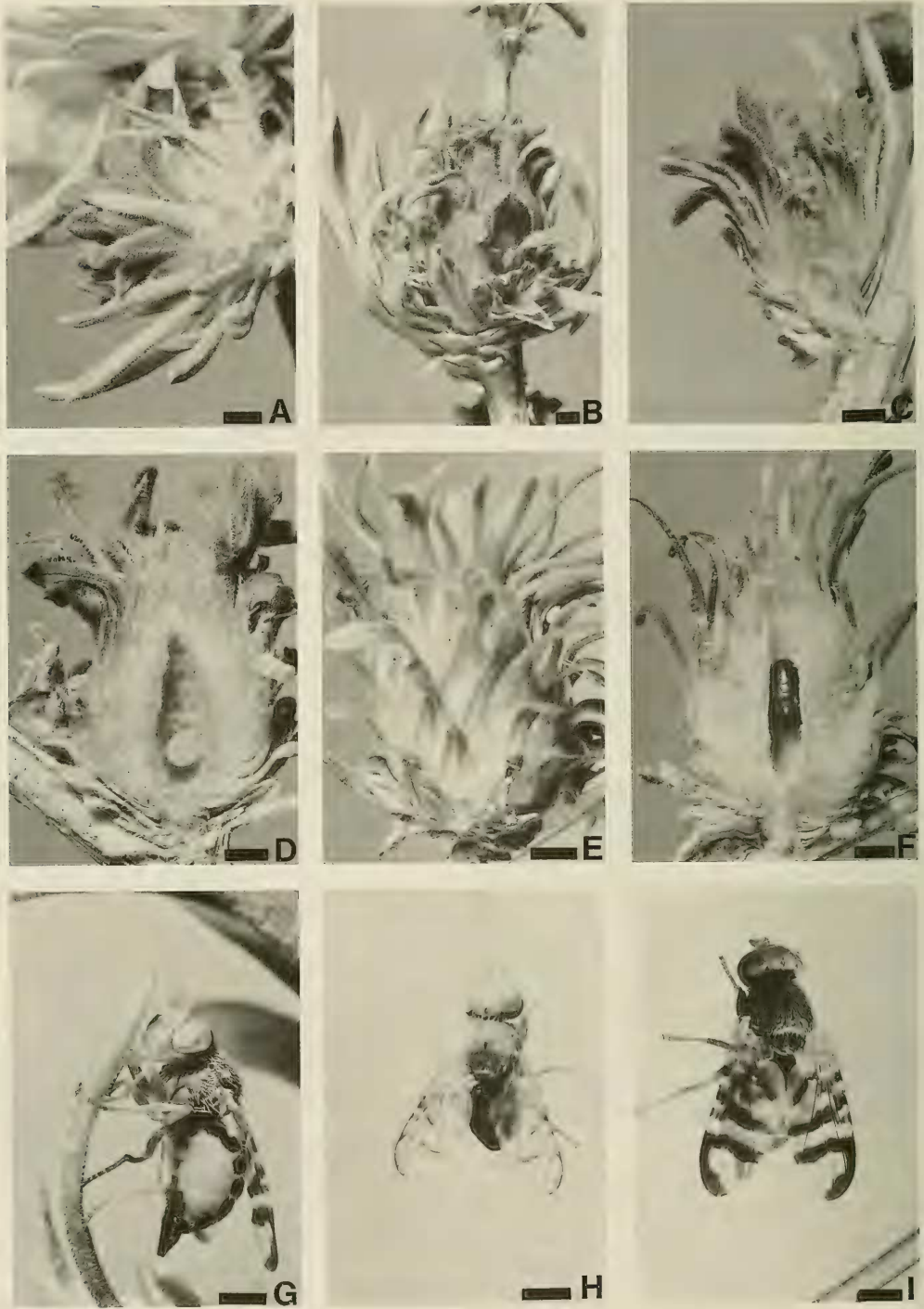


Fig. 7. Life stages of *Aciurina idahoensis* on *Chrysothamnus viscidiflorus* from California: (A) overwintered immature gall with dead leaves at base, (B) developing gall that contained a second instar, (C) saggital section of young gall with second instar in basal feeding chamber, (D) saggital section of gall containing early third instar, (E) full-size gall containing a puparium, (F) saggital section of gall containing puparium, (G) lateral view of newly emerged female, (H) dorsal view of male, (I) dorsal view of female. Line = 1 mm.

Nine galls containing third instars measured 12.1 ± 1.0 (range, 9.5–19.0) mm in length and 6.8 ± 0.4 (range, 4.6–8.6) mm in width (Fig. 7D, E). The elongated, ellipsoidal, central chamber averaged 6.2 ± 0.6 (range, 2.0–8.1) mm in length and 1.8 ± 0.2 (range, 0.8–2.5) mm in width (Fig. 7D); the surrounding gall wall was 1.10 ± 0.18 (range, 0.56–2.24) mm wide at its thickest point (Fig. 7C). The leaves adorning this gall laterally measured 10 mm long by 1 mm wide (Fig. 7E).

Pupa.—Prior to pupariation, the fully formed third instar eats through the apical end of the gall chamber and kills the apical bud and surrounding apical leaves, which turn brown, forming an exit channel for the adult. The puparium has its anterior end facing this exit channel (Fig. 7F). Twenty-two mature galls containing puparia measured 14.6 ± 0.4 (range, 11.0–20.0) mm in length and 8.8 ± 0.3 (range, 6.0–12.0) mm in width. The open central cavities, including the exit channel, measured 9.0 ± 0.3 (range, 6.2–11.0) mm in length and 2.1 ± 0.1 (range, 1.3–2.8) mm in width (Fig. 7F). The gall wall (Fig. 7F) measured 2.85 ± 0.11 (range, 1.68–3.64) mm at its widest. The leaves laterally adorning these galls measured 7–20 mm in length by 1–2 mm in width. This compares with mean gall lengths of 10.8 mm (range, 8.0–14.5 mm) and widths of 7.6 mm (range, 6.0–9.0 mm), and mean central cavity lengths of 8.0 mm (range, 4.5–12.0 mm) and widths of 2.0 mm (range, 1.5–3.0 mm) for 45 mature galls reported by Wangberg (1981). Apparently, galls of *A. idahoensis* tend to be slightly larger in California than in Idaho, if the samples compared are representative. Otherwise, no biologically significant differences in the galls were detected which would suggest separate species status for flies from these two States.

Adult.—The adult emerges from the apex of a gall by pushing aside the dead, basally excised bracts with its expanded pilinum. Once the latter organ was free, one observed female emerged completely

in a few seconds, and within about 5 minutes had fully expanded her wings (Fig. 7G). Newly emerged females contain many ova and their ovaries occupy and distend much of their abdomens (Fig. 7G). In the insectary, eight males lived 21 ± 8 (range, 13–38) days; two females, 14 and 22 days. Figures 7H and 7I further document the sexual dimorphic wing patterns of the male and female, respectively, in California.

Seasonal history.—Like *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996), *A. idahoensis* is univoltine on its shared, single host plant, *C. viscidiflorus*, in California. Together with *A. semilucida*, these four species partition *C. viscidiflorus* seasonally and altitudinally, with adults of *A. idahoensis* and *A. semilucida* emerging, mating, and ovipositing earlier in spring (May–June) at lower altitudes (<1800 m) than *A. ferruginea* and *A. michaeli*, which emerge, mate, and oviposit in summer (July–August) at higher elevations (>2100 m) (Goeden and Teerink 1996, unpublished data). Adults and galls of all four *Aciurina* spp. have not been found together, only paired as reported from separate locations in California (Goeden and Teerink 1996).

Natural enemies.—Wangberg (1981) reported the following Hymenoptera (Chalcidoidea) as associated with *A. idahoensis* (as “*Aciurina* sp. A”) and its galls in Idaho: *Eurytoma chrysothamni* (Eurytomidae), solitary endoparasitoid; *Eupelmus* sp. (Eupelmidae), unknown relationship; *Torymus* sp. (Torymidae), ectoparasitoid?; *Halticoptera* sp. (Pteromalidae), solitary endoparasitoid; *Platygaster* sp. (Platygasteridae), unknown relationship. A single specimen of *Halticoptera* sp. was reared from a puparium as a primary, solitary endoparasitoid in our samples from California.

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